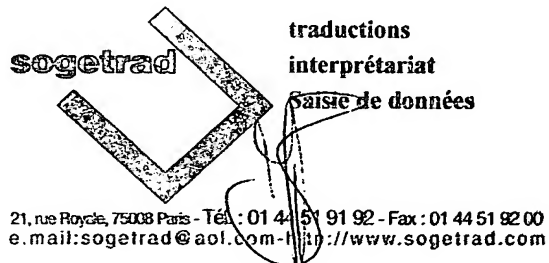


TRANSLATION CERTIFICATE

We, SOGETRAD SARL – 21 rue Royale, F-75008 PARIS, hereby certify and attest that this translation was made by a translator whose native tongue is English, and who has a perfect knowledge of the French language, and that this translation is true and sincere as far as he knows,

AND

we make this declaration conscientiously believing the statement contained herein to be true in every particular.



Signed in Paris, France
on March 11, 2004

Address sequencing in a domain name server

This invention relates to telecommunication networks, and in particular
5 those using the IPv6 (Internet Protocol, version 6) protocol stack. More precisely,
it concerns the resolution of addresses in a domain name server associated with
such telecommunication networks.

Such domain name servers are well known in the state of the art, and are
conventionally known as Domain Name Servers or DNS. The operation of the
10 DNS is standardised and described in RFCs 1034 and 1035 of the IETF (Internet
Engineering Task Force).

The purpose of domain name servers is to simplify addressing within an IP
telecommunication network. They behave like telephone directories, associating
the symbolic names of network elements (or domain names), which represent no
15 reality in the network, with the numerical addresses of these network elements.

Thus, when a first network element wants to address a data stream to a
second network element, it can use either the address of this second network
element, if it is known, or the symbolic name of this second element.

In this latter case, the first network address element sends a request
20 containing this symbolic name to the domain name server. In return, it receives
the numerical address or addresses corresponding to this symbolic name. It can
also send the data stream to the second network element using its address.

However, a problem arises when a single domain name is associated with
several addresses. This is the case in particular in a network employing the IPv6
25 protocol stack, where the IPv6 specifications actually allow the association of

several addresses with a single network element.

The use of a DNS system in an IPv6 type network is described in RFC 1886 of the IETF, entitled "*DNS Extensions to Support IP Version 6*".

These addresses can be addresses of different levels. As described in
5 RFC 2373 of the IETF, entitled "*IP version 6 Addressing Architecture*", there exist different types of address, differentiated on the basis of a prefix. There are therefore addresses with a global value, and addresses with a local value, particularly local to a site. When the sender and the recipient of the data stream are located in a single addressing space (a site), it is best to use a local address
10 proper to this addressing space. This type of address local to a site will later be referred to also as a site address.

In any other case, the global address should be used, because otherwise the data stream cannot be correctly routed to the recipient.

If the global address is always used, then the data streams will be routed
15 correctly, but use of the network will not be optimal. Moreover, no guarantee is given regarding whether the data streams will ever leave the site.

It is possible to have addresses of different natures, like an IPv6 address and one known as a "6to4" address, for example, as described by RFC 3056 of the IETF, entitled "*Connection of IP Domains via IPv4 Clouds*".

20 This is one of the mechanisms used for the gradual migration of an IPv4 type network to an IPv6 type network.

The "6to4" mechanism allows purely IPv6 network elements to communicate with other IPv6 network elements via purely IPv4 network elements. In order to achieve this, a particular type of addresses, known as "6to4
25 addresses", is defined. The addresses of this type are recognisable by the

network elements because they begin with the prefix "2002". Thus on receipt of a packet bearing such an address, a network element at the edge of the IPv6 site is able to encapsulate it in an IPv4 packet so that it can get it to its destination.

Use of the wrong address could lead to receipt of an IPv6 address by a network element which is compatible with IPv4 only, or indeed to an unacceptable limitation of the addressing space. The result would be failure to route the data stream.

In these two situations, a single name is associated with several addresses. The domain name server therefore sends all of these addresses as its response to a request, and the network element which has sent the request arbitrarily uses any of these addresses.

Now in the first situation, the use of an inappropriate address is not optimal from the network viewpoint.

Furthermore, in the second situation, the use of an inappropriate address may not allow correct addressing of the network element one wishes to reach.

There exist solutions which consist of sequencing the addresses, or indeed of assigning choices of different addresses according to certain criteria, but these solutions consist of performing the choosing or the sorting at the level of the applications. Such solutions are described, for example, in the document entitled "draft-ietf-ipngwg-default-addr-select-05.txt" dated 4 June 2001.

However, such a solution overloads the applications and, by allowing them too much freedom, can give rise to incorrect behaviour patterns in the whole of the communication network. In addition, an application may not have sufficient sight of the network in order to enable it to choose the optimum address. Finally, such a solution does not allow the deployment of an overall network

management policy.

The aim of the invention is to overcome the drawbacks of the current state of the art, by allowing the network element sending out a data stream to use the most effective and optimum address.

5 To this end, the subject of the invention is a domain name server associated with a data network, which include:

- means for receiving requests containing a domain name, and
- means for returning a response, containing one or more addresses associated with a domain name, to the sender of the request.

10 According to the invention, this domain name server is characterised in that this address, or these addresses, are sequenced by the domain name server inside the response.

According to one embodiment of the invention, this sequencing is effected as a function of the content of the request.

15 Sequencing can also be effected according to the topology of the network, where the most local address allowing one to address both the said sender of the request, and the network element corresponding to the domain name, is inserted first.

20 Sequencing can also be effected so that in the event of the presence of an IPv4 cloud between the sender of the requests and the network element corresponding to the domain name, and address of the "6to4" type is inserted first.

The invention and its advantages will appear more clearly in the description which follows below, together with the appended figures:

- 25
- Figure 1 illustrates a first implementation of the invention.

- Figure 2 represents a second implementation of the invention.

Figure 1 illustrates a network element composed of two sites (S and S'). Site S contains network elements R_1 , R_2 and R_3 , and site S' contains network element R_4 .

As mentioned previously, there are different types of IPv6 addresses, which can be distinguished by different prefixes.

Among these address types, there are site-local addresses (or site addresses) and global addresses.

A site-local address is recognised because it is of the form "FEC0::/10", which means that the first 10 bits have the value FEC0 and the following 118 represent the addressing space proper. Similarly, a local link address is recognised because it is of the form "FE80::/80".

As a result, network element R_4 , for example, can have a global address a_g and a site-local address a_s . This global address a_g can be like that defined in RFC 2374, entitled *"An IPv6 aggregatable Global Unicast Address"*. This allows network element R_4 to enter into communication with network elements located at other sites, such as, for example, network element R_1 located at site S.

Let us assume that network element R_1 wants to transmit a data stream to network element R_4 .

To this end, it sends a request R to domain name server D, containing the symbolic name or domain name of network element R_4 .

According to the invention, domain name server D is able to sequence the different addresses of the wanted network element in the response provided to the sender of the request R.

To this end, it can use information contained in this request R. Among this

information, in particular, is the source address of the request, that is the address of network element R_1 . Knowing the addresses of network elements R_1 and R_4 , as well as the topology of the network, the domain name server is then able to determine the type of address to be used. In the present example, it is able to determine that network elements R_1 and R_4 are not located at the same site, and therefore that the local address must not be used.

Disregarding other possible addresses, the server D therefore sequences the addresses in the order $a_g a_s$ in the response R' which it is sending to network element R_1 .

On receipt of this response R' , network element R_1 is able to determine the address to use by selecting the first in the sequence, namely address a_g . It can then use address a_g to insert as the destination address in the data stream packets F which it is transmitting to network element R_4 .

Without this sequencing, performed by the domain name server D, network element R_1 would have no means of determining the address that it must use. It might then have used the local address a_L , which would have led, in this case, to failure to route the data stream F .

In other words, the sequencing performed by the domain name server D is effected as a function of the request. If the source address of the request is a local address, and if the name requested has a local address, it is the local address which will be sent first.

In general, what is involved is inserting the most local address in the first position, thereby enabling the addressing of both the sender (here network element R_1) of request R and the network element corresponding to the wanted domain name (here network element R_4).

If network element R_1 wishes to transmit a data stream to network element R_3 , the domain name server sends its site-local address first (if it exists), so that network element R_1 can use this in its communications with R_3 .

Figure 2 illustrates a second implementation of the invention in the context of a heterogeneous network composed of IPv4 network elements and IPv6 or IPv4/IPv6 network elements.

Various mechanisms exist. In this example, the “6to4” mechanism is used. However, the invention is designed to apply to different mechanisms from the moment when different addresses are necessary.

In this example, a data network is composed of two domains N_A and N_B separated by a cloud N_4 , composed only of IPv6 network elements. This example illustrates the normal case of two sites which have migrated to the IPv4 technology, and which are connected via a third network by a telecommunication operator, not yet having migrated and still compatible only with the IPv4 protocols.

Network elements A and B are routers connecting cloud N_4 to domains N_A and N_B respectively.

In each of the domains, N_A and N_B , we have a domain name server (or DNS), D_A and D_B respectively. It is assumed that the two servers, D_A and D_B , are suitably configured, and mutually possess their correct address.

In a first stage, the sending network element x , wanting to transmit a data stream to a recipient network element Y , located in domain N_B , sends a request R to domain name server D_A associated with domain N_A . This request R contains the symbolic name of the recipient Y , and contains a source address which is an address of the sender x .

On receipt of this request R, server D_A determines whether it possesses an association between the symbolic name contained in the request and an address. Since the recipient is outside domain N_A "controlled" by server D_A , this association does not appear in the tables or in the database of server D_A .

5 According to a recursive configuration, it transmits the request to the domain name server D_B of domain N_B .

Since the recipient Y and the server D_B form part of the same domain N_B , the latter possesses the information relating to the recipient Y and to the association of its (symbolic) domain name and its addresses. In this example, the

10 recipient Y possesses at least two addresses:

- an a_{v6} address which conforms to the IPv6 protocol which allows network element Y to communicate with the other network elements of domain Y or with network elements of other IPv6 domains (not shown),
 - an a_{6to4} address which conforms to the "6to4" technology mentioned
- 15 previously, allowing the communication of two IPv6 network elements via an IPv4 cloud.

According to the invention, domain name server D_B sequences the two (or more) addresses corresponding to the symbolic name of the wanted network element Y.

20 Sequencing can be effected as a function of the content of the request transmitted by domain name server D_A . In fact this request contains the address of the sender (domain name server D_A), which allows domain name server D_B to determine that since the source address is one of the "6to4" type, then "6to4" technology should be used.

25 It is therefore able to determine that the relevant address is the a_{6to4}

address of the recipient Y, and as a consequence, it is able to sequence the various addresses by putting the most relevant address a_{6to4} (the "6to4" address of recipient Y) first, and inserting these sequenced addresses in a response R'.

This response is then sent to domain name server D_A , which is then able
5 to respond to the request from the sender x.

According to the invention, this sender is capable of interpreting the sequence of addresses in the response R'. This interpretation can consist of simply using the first address contained in the response. This first address is the A_{6to4} address, which is compatible with the "6to4" mechanism.

10 The sending network element x can use the a_{6to4} address to address the data stream to the recipient network element Y. This data stream F will traverse network elements A and B and cloud N_4 , being routed correctly.

In other words, the sequencing performed by the domain name server D_B is effected in such a manner that in the case of the presence of an IPv4 cloud
15 (here N_4) between the sender of the request (here X) and the network element corresponding to the domain name contained in the request (here Y), and address of the "6to4" type (here a_{6to4}) is inserted first.

It is as a result of this sequencing effected by the domain name server D_B that the sending network element x is able to determine the a_{6to4} address to be
20 used.